Wadden Sea Monitoring with TerraSAR-X and Sentinel-1

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We compare the suitability of the two satellites TerraSAR-X and Sentinel-1 for monitoring changes in the Wadden Sea. The tasks chosen for this case study are retrieving the extension of tidal flats and identifying locations of blue mussel beds.

Tidal flats are areas which are flooded during high tide but dry during low tide. In the German Bight, these areas extend up to 20km off the shore and are a protected habitat for many animals and plants. However, monitoring the extension of these tidal flats is not only important for ecologic reasons, but also for maritime safety: all ship traffic to the port of Hamburg sails through the Elbe estuary, part of the Wadden Sea. With the next level of the Elbe deepening currently in progress, major dislocations are expected in the mudflats due to altered erosion and sedimentation patterns. With the regular monitoring interval (surveys conducted by ships and aircrafts) of 6 years off the main fairway, additional monitoring capabilities based on satellite remote sensing are in high demand by the authorities.

Several areas of the tidal flats are coved by blue mussels, the only type of mussel native to the Wadden Sea living on the surface. These mussels attach themselves to the ground and to each other, forming mussel beds with areas often exceeding one square kilometre. Due to their important role in the ecosystem, e.g. for water filtering, and their endangerment by fishery, the mussel beds are frequently monitored, either on foot or with airborne surveys at low tide. Using satellite remote sensing and especially SAR due its all-weather capability, these monitoring tasks could be strongly simplified or even fully automated.

In our comparison, we find the high data availability of Sentinel-1 a strong benefit for the monitoring task. The orbit constellation of the Sentinel-1 A and B satellites allows a repetition frequency of six days for the same orbit and an almost daily coverage of the investigation area using all available orbits. This is important for the Wadden Sea monitoring as only low tide scenes are of interest; the lower the water the more mudflats are exposed. We found that Sentinel-1 allows for a low tide scene every two to three weeks. With winter storms which can cause several months of erosion processes in a single day, a timely before-after comparison might be beneficial. TerraSAR-X, on the other hand, benefits strongly from the possibility of high resolution using the Stripmap mode for wide coverage or the Spotlight mode for more localized monitoring. Features on the mudflats like mussel beds are more easily discernible and the high resolution allows the detection of smaller features, enhancing the possibility for automatic classification of mussel beds.